CLAIMS

1. Non-invasive device for measuring blood temperature in a circuit for the extracorporeal circulation of blood, this device comprising a line (20) in which blood taken from a patient flows (P), and a temperature sensor (19), connected to the said line (20) and generating a first signal (V_B) correlated with the temperature (T_P) of the blood flowing in the said line, characterized in that the said temperature sensor (19) comprises a device (21) for measuring the intensity of an electromagnetic radiation, and the said line (20) comprises a connecting portion (37) facing the said measuring device (21) and permeable to electromagnetic radiation in a first wave band (B_S); the said first signal (V_B) being correlated with the intensity of the said electromagnetic radiation in the said first band (B_S).

2. Device according to Claim 1, characterized in that the said measuring device (21) is housed within a casing (23), behind a window (24) formed in the said casing (23); the said connecting portion (37) of the said line (20) being completely superimposed on the said window (24), in such a way that it completely covers the solid angle of view of the said measuring device (21).

3. Device according to Claim 1 or 2, characterized in that the said measuring device (21) comprises a thermopile, having at least one hot junction (21a) and at least one cold junction (21b).

4. Device according to Claim 3, characterized in that the said temperature sensor (19) comprises means (22) of controlling the temperature, to keep the cold junction (21b) of the said measuring device (21) at a controlled temperature (T_0).

5. Device according to Claim 4, characterized in that the said control means (22) comprise:

- a thermistor (28), connected thermally to the cold junction (21b) of the said measuring device (21), and supplying a second signal (S_{TP}), correlated with the said controlled temperature (T_0);
- a solid state heat pump (29), having a low temperature surface (32) thermally connected to the said measuring device (21), and a high temperature surface (34); and
- a control circuit (30), connected to the said thermistor (28), to receive the said second signal (S_{TP}), and to the said heat pump (29), to supply a control signal (I_C) correlated with the said second signal (S_{TP}).

6. Device according to Claim 5, characterized in that the said heat pump (29) comprises a Peltier cell.

7. Device according to Claim 5 or 6, characterized in that it comprises a heat sink element (35) placed in contact with the said high temperature surface (34) of the said heat pump (29).

8. Device according to any one of Claims 5 – 7, characterized in that the said controlled temperature (T_0) is a constant temperature in the range from 5°C to 15°C.

9. Device according to any one of the preceding claims, characterized in that the said connecting portion (37) is made from a material having an essentially constant transmittance and negligible absorbance in the said first waveband (B_S).

10. Device according to any one of the preceding claims, characterized in that the said connecting portion (37) is made from a material having an essentially constant transmittance in a temperature range from 30°C to 40°C.

11. Device according to any one of the preceding claims, characterized in that the said connecting portion (37) is made from a material chosen from the group consisting of high-density polyethylene, low-density polyethylene, and poly(4-methyl-1-pentene).

12. Device according to any one of the preceding claims, characterized in that it comprises filter means (38) interposed between the said measuring device (21) and the said connecting portion (37) of the said line (20).

13. Device according to Claim 12, characterized in that the said filter means (38) comprise a sheet of material which is essentially opaque to electromagnetic radiation outside a second waveband (B_P) lying within the said first waveband (B_S).

14. Device according to Claim 13, characterized in that the said second waveband (B_P) is in the range from 8 μm to 14 μm.

15. Device according to Claim 13 or 14, characterized in that the said filter means (38) are made from germanium.

16. Device according to any one of Claims 12 – 15, characterized in that the said filter means (38) have one face (40) facing the said connecting portion (37) of the said line (20).

17. Device according to any one of the preceding claims, characterized in that the said first waveband (B_S) is at least partially contained within the infrared radiation band (IR).

18. Device according to Claim 4, characterized in that it comprises a control unit (16a) associated with the said temperature sensor (19), for receiving the said first signal (V_B) and for determining the said blood temperature (T_P) according to a relation of the type:

$T_P = F(V_B) + T_0$

19. Device according to Claim 18, characterized in that the said relation is:

$T_P = K^*V_B + T_0$

where K is an experimentally determined constant.

20. Control equipment for an extracorporeal blood circuit (2), in which the extracorporeal circuit (2) is connected to a blood purification machine (1; 45) and comprises an arterial branch (11) and a venous branch (13) connected to at least one blood treatment element (3; 3, 15a; 3, 15b; 45; 45, 15a; 45, 15b), the equipment (10) being characterized in that it comprises a non-invasive device (16) for measuring the blood temperature (T_P) according to at least one of Claims 1 to 19.

21. Equipment according to Claim 20, characterized in that the non-invasive device (16) has a sensor (19) for measuring a first temperature (T_P) of the blood leaving a patient (P) along the arterial branch (11) upstream of the said blood treatment element (3; 3, 15a; 3, 15b; 45; 45, 15a; 45, 15b), a control unit (16a) for regulating the blood temperature (T) as a function of the first temperature (T_P) and a reference temperature (T_{SET}), and a device (18) for regulating the blood temperature (T) which is connected to a portion (13a) of the venous branch (13) downstream from the said blood treatment element (3; 3, 15a; 3, 15b; 45; 45, 15a; 45, 15b).

22. Equipment according to Claim 21, characterized in that the said regulating device (18), is combined with the said portion (13a) to form a heat exchanger; the said control unit (16a) being connected to the said temperature regulating device (18).

23. Equipment according to Claim 21 or 22, characterized in that the said regulating device (18) comprises a line (18a) for conveying a fluid which can be heated to a temperature (T_F) which lies within a specified range, approximately around 37° C.

24. Equipment according to one of Claims 21 to 23, characterized in that the said regulating device (18) has a seat (18b) for housing the said portion (13a) of the venous branch (13).

25. Equipment according to one of Claims 21 to 24, characterized in that the said extracorporeal circuit (2) is connected to a pump (12) to convey the blood along the extracorporeal circuit (2), the equipment (10) comprising a sensor (17) for detecting the operating state of the pump (12); the control unit (16a) keeping the temperature (T_F) of the said fluid equal to the said predetermined temperature (T_{SET}) when the pump (12) is not in operation.

26. Equipment according to one of Claims 21 to 25, characterized in that the said venous branch has a post-dilution node (15b); the said portion (13a) being located downstream of the said post-dilution node (15b).

27. Equipment according to any one of Claims 21 to 26, characterized in that the said blood treatment element (3; 3, 15a; 3, 15b) consists of a haemodialysis filter (3) comprising a blood compartment (5) and a dialysate compartment (6) within which a dialysate flows.

28. Equipment according to one of Claims 21 to 26, characterized in that the said blood treatment element (3; 3, 15a; 3, 15b) comprises a haemodialysis filter (3) comprising a blood compartment (5) and a dialysate compartment (6) within which a dialysate flows, and a pre- or post-dilution node (15a; 15b) for the introduction of a replacement fluid.

29. Equipment according to one of Claims 21 to 26, characterized in that the said blood treatment element (45; 45, 15a; 45, 15b) consists of a haemofiltration filter (45).

30. Equipment according to one of Claims 21 to 26, characterized in that the said blood treatment element (45; 45, 15a; 45, 15b) comprises a haemofiltration filter (45) and a pre- or post-dilution node (15a, 15b) for the introduction of a replacement fluid.

31. Equipment according to Claim 21, characterized in that the said control unit (16a) regulates the temperature (T) as a function of the first temperature (T_P) and the reference temperature (T_{SET}) at predetermined time intervals.

32. Equipment according to Claim 21 or 31, characterized in that the said control unit (16a) regulates the temperature (T) as a function of the difference between the first temperature (T_P) and the reference temperature (T_{SET}).